http://ansinet.com/itj

ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 6 (4): 593-596, 2007
ISSN 1812-5638

Research on the Frame Traffic of Wireless Local Area Network

Ge Xiaohu and Zhu Yaoting
Department of Electronics and Information Engineering,
Huazhong University of Science and Technology, Wuhan, 430074, People's Republic of China

Abstract: Because the channel of wireless LAN is more complex than that of wired LAN, the traffic running in the channel is the key of estimation of behavior model in the wireless LAN. We have compared the IP packet traffic and MAC frame traffic and analyzed the difference between these two traffics and then we have found the frame traffic is more suitable for describing the behavior of WLANs than that of packet traffic. Basing on these results, we present the questions in the research of wireless LAN traffic and explore the challenges in the studies of WLAN frame traffic.

Key words: WLAN, traffic, MAC protocol, frame data, QoS

INTRODUCTION

With the development of wireless communication technologies, WLANs (wireless local area networks) based on the IEEE 802.11a/b/g standards have enjoyed an unprecedented adoption rate in the recent years. Evolving from networks which provide rudimentary services, the thrust of current development efforts is toward providing a richer set of quality sensitive application. Various network mechanisms and algorithms have been proposed to improve the performance of WLANs and vast research of WLANs involving the protocols design, the simulation of algorithms, the modeling of scheme and estimation of performance have been carried out (Crow *et al*., 1997; Ware *et al*., 2000; Ge *et al*., 2003, 2004, 2006; Eshghi and Elhakeem, 2003). However, the majority of research results is based on the understanding of traffic characteristics in WLANs, thus the network traffic research imaging the behavior characteristics of WLANs is becoming a hotspot.

Formerly, limited by the measurement techniques in WLANs, it is impossible for researchers to analyze the actual traffic from WLANs. However, in the recent past, with the improvement in the measurement technology used in WLANs and investigation of behavior characteristics of WLANs, some papers about traffic of WLANs have been published. Kin *et al*. (1994) presented two stochastic traffic models for a portion of a wireless network along a highway and numerical simulations are proposed to illustrate how the models can be used to investigate various aspects of time and space dynamics in wireless networks. Aguayo *et al*. (2004) analyzes the causes of packet loss in an urban multi-hop 802.11b network and the analysis results indicate that the large number of links with intermediate loss rates is probably due to multi-path fading rather than attenuation or interference. Mahajan *et al*. (2006) develops a non-intrusive tool building on passive monitoring to analyze the detailed MAC-level behavior of operational wireless networks and then measures a WLAN using this tool. They find that the network predominantly had low contention and that the medium was inefficiently utilized during those times. Reis *et al*. (2006) proposes practical models for the physical layer behaviors of packet reception and carrier sense with interference in static wireless networks, moreover, these models can be used to predict packet delivery and throughput in the same network for different sets of transmitters with the same node placements. Jardosh *et al*. (2005) discusses how congestion in a network can be estimated using point-to-point link reliability and analyzes the correlations between the link reliability and behavior properties such as frame retransmissions, frame sizes and data rates. Papagiannaki *et al*. (2006) examines the quality of links in home wireless networks and finds that wireless links in the home are highly asymmetric and heavily influenced by precise node location, transmission power and encoding rate, rather than physical distance between nodes. In these measurements, many links were unable to utilize the maximum transmission rate of the deployed 802.11 technology. Kotz and Essien (2005) investigates the comprehensive trace of network activity in a wireless campus LAN and analyzes the impact of student usage patterns on the WLANs. Yin and Lin (2005) collects the traffic from a wireless mesh network and finds that the network traffic has obvious self-similar characteristic. All

Corresponding Author: Ge Xiaohu, Department of Electronics and Information Engineering,
Huazhong University of Science and Technology, Wuhan, 430074, People's Republic of China

above research results validate that research on the network traffic is critical for design and evaluation of network protocols as well as network deployment.

In general, the majority of research on the network traffic is based on the measurement and analysis of packets from the network layer in the WLAN protocol architecture. In the wired network, it is effective to investigate the network behavior according to the analysis of network traffic from IP packets. But there are some problems when we try to investigate the wireless network behavior from the IP packet traffic, the reason is that the WLANs essentially is a 2-Layers network which just includes the data link layer and physical layer. Hence, features of protocol architecture in the WLANs necessitate the comprehensive understanding of frame traffic in the data link layer.

IMPACT OF ARCHITECTURE OF WLAN ON THE TRAFFIC

In 1969, the first wired network (it is the ARPA network) had been built in the America and then the wired networks have been covered the entire world in the following 30 years. As we cross the threshold of the next century, the human society is moving from the industrial economy into the knowledge-based economy. The main features of knowledge-based economy are the globalization and informatization which are based on the network system. In order to promote the standards of LAN (Local Area Network), the technical committees of the IEEE societies developed serials of standards, such as IEEE 802.3/4/5/6 standards. However, the publication of standards of WLAN just emerged in the recent years. In 1997, the technical committees of the IEEE societies published the first generation WLAN standard-----IEEE 802.11 standard (1997) and then a serial of standards, such as IEEE 802.11a/b/g, was developed. Today, those standards already widely deployed in the WLAN (1999, 2000).

The star topology structure has been usually adopted in the WLAN, which means there is one node worked as the AP (Access Point) and other nodes just communicate with the AP. So there is one hop link for most nodes in the WLAN and it is not necessary for most nodes to select route which has been shown in the Fig. 1.

As a result, there are just the data link layer and physical layer in the protocol architecture of WLANs. Of course, in order to connect with Internet, the AP has a network layer used to select route and a transport layer used to guarantee the reliable transmission (Xu *et al*., 2004). Hence, the IEEE 802.11 protocol architecture has been shown in the Fig. 2.

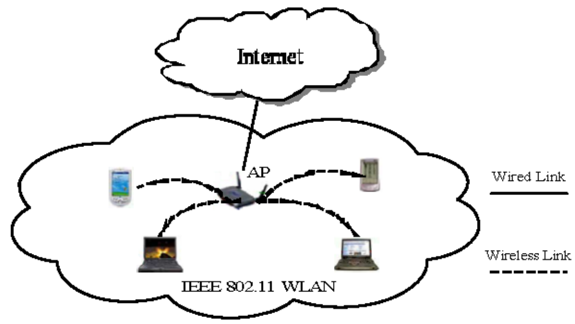

Fig. 1: Topology of WLANs

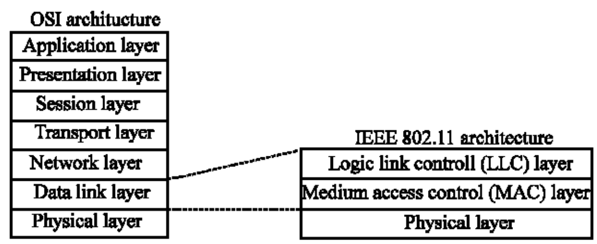

Fig. 2: Relationship between OSI architecture and IEEE 802.11 architecture

In the Fig. 2, the physical layer is directly related to the communication method and data link layer takes charge of reliable transfer of information across the physical link. In the IEEE 802.11 architecture, the data link layer has been divided into the LLC and MAC layer. The capability of LLC layer is to transfer the frame into the physical layer, which is independent of transmission medium; the MAC layer provides the capability to solve the problem of shared transmission medium, which depend on the transmission medium. There is an essential difference in the transmission medium between the wired LAN and wireless LAN, so that the MAC mechanism of wired LAN is different with that of the wireless LAN. In the wired LAN the CSAM/CD (Carrier Sense Multiple Access with Collision Detection) mechanism has been adopted in the MAC layer and the CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) mechanism has been adopted in the MAC layer of wireless LAN (Alam, 1993; Ziouva and Antanakopoulos, 2002). The main difference between CSMA/CD and CSMA/CA mechanism is that a wireless node can not listen to the channel at the same time it is sending data in this channel, so it can not detect a collision in the wireless LAN. In order to solve the collision problem in the wireless LAN, the CSMA/CA mechanism triggers a brief transmission (such as an ACK frame) from the intended receiver before transmission a packet. On the other hand, to solve the hidden problem, the RTS/CTS frame has been introduced in the MAC layer of WLANs.

The CSMA/CA mechanism has been adopted in the WLANs, which is designed according to the characteristics of wireless communication medium. So some additional frames have been transmitted based on CSMA/CA mechanism, which are just processed in the data link layer. Hence, if we want to know the real traffic in the air of WLANs, we can not just focus on the IP packets in the WLANs.

QUESTIONS IN THE TRAFFIC RESEARCH OF WLANS

Compared with wired LAN, there are some differences in the protocol architecture and MAC mechanism of WLANs. And now, we will analyze some questions in the WLANs traffic research.

The WLANs is mainly based on the IEEE 802.11a/b/g protocols, which only include a data link layer and a physical layer. The physical layer mainly deals with the bite symbols, so the object in the physical layer is the bite traffic. The MAC layer is the most important part in the data link layer and the object processed in the MAC layer is frame traffic. The frames in the MAC layer have been divided into the management frames and data frames. The management frame is the management data created by the MAC protocol, such as the CSMA/CA mechanism, which is used to build the wireless link in the shared medium. The management frames include the broadcast frame, request frame, reply frame and so on, but all of these frames do not include the IP packets. The data frame is used to transmit data after the wireless link has been built and the IP packet has been encapsulated into the data frame.

Researchers analyze some actual traces in the WLANs based on the IEEE 802.11 technology and find that only 40% of the overall transmission time is spent sending original data packets (Rodrig, 2006). Most of the remaining transmission time is spent on retransmission, acknowledgments and management frame traffic. Moreover, the retransmission and management frame traffic are accounting for 38% of all data transmission. It is means that many time and traffic is used to transmit the management and retransmission frames, so the numbers of management and retransmission frames directly impact the efficiency of WLANs. However, the vast majority of earlier traffic studies are overwhelmingly based on traces taken on wired segments adjacent to APs. According to the IEEE 802.11 standards, the retransmission and management frames are transparent for the network layer, which means these frames have not been recorded into IP packets. Hence, in the WLANs, a part of data transmitted in the air has been ignored by the IP traffic. This makes it important to study the frame traffic in the MAC layer for WLANs.

RESEARCH CHALLENGES IN THE FRAME TRAFFIC OF WLANS

Some main objectives of research in the wired network are the improvement of transmission efficiency and guarantee the QoS (Quality of Service) and these objectives are also suitable for the WLAN's studies.

In the wired network, the transmission efficiency has been decreased by the retransmitted packets. So the characteristics of retransmitted packet traffic can be studied by investigating the packet traffic and then research results can be used to improve the transmission efficiency in the wired network. Nevertheless, the reason caused the decrease of transmission efficiency in the WLANs is that the retransmission and management frames occupied too much transmission time, which conduce to the reduction in throughput rate of WLANs. Because these frames can not be observed in the IP packet traffic, we can not find out the correct approach to increase the throughput rate id we just focus on the IP packet traffic. In order to face this challenge, the WLAN frame traffic should be measured and analyzed to understand the characteristics of network behavior in the air. Moreover, the model of frame traffic could be built and the performance of corresponding models could be analyzed. Based on these research results, the protocols in the WLANs, such as MAC mechanisms, could be modified to improve the transmission efficiency.

The descending of QoS in the wired network is caused by the network congestion and the network congestion can be understood by modeling and analyzing the IP packet traffic. Based on the model of IP packet traffic, the new administration schemes could be proposed to reduce the phenomena of network congestion and improve the QoS in the wired network. In the WLANs, the factor caused the decrease of QoS is the retransmission frames which are not contained in the IP traffic. To answer this challenge, the distribution of retransmission frames should be measured and analyzed and then some MAC schemes and algorithms could be revised based on the characteristics of retransmission frames.

Considering the challenges in the WLANs, the research on the frame traffic is critical to improve the transmission efficiency and QoS. In this aspect, there are many work should be carried out to promote this research, such as the measurement and analysis of frame traffic, modeling of frame traffic and so on.

CONCLUSIONS

In this study, we first briefly introduce some traffic studies in the WLANs and then we analyze the difference between the wired network and WLANs in the field of protocol architecture and MAC mechanisms. Basing on these analyses, we point out the problems existing in the WLANs traffic studies and state that the packet traffic could be substituted by the frame traffic to characterize the behavior of WLANs. Moreover, some challenges in the frame traffic research have been illustrated and some research fields involved in these challenges have been described to improve the performance of WLANs. Finally, we believe that we have just scratched the surface when it comes to extracting information from deeper investigation in this topic. More measurements and analyses of frame traffic are a prime area for future work that may provide deeper insight into the effectiveness of WLANs. In the long term, we hope these insights can be leveraged by wireless nodes to improve the quality of wireless network as deployed and used in practice.

REFERENCES

Aguayo, D., J. Bicket, S. Biswas, G. Judd and R. Morris, 2004. Link-level measurements from an 802.11b mesh network. IEEE SIGCOM 2004, Portland, Oregon, USA.

Alam, M., 1993. Retransmission probability selection of multichannel CSMA/CD protocols for LANs. Comp. Commun., 7: 630-635.

Crow, B.P., I. Widjaja, J.G. Kim and P.T. Sakai, 1997. IEEE 802.11 wireless local area networks. IEEE Commun. Mag., 35: 116-126.

Eshghi, F. and A.K. Elhakeem, 2003. Perfoemance analysis of ad hoc wireless LANs for real-time traffic. IEEE J. Selected Areas Commun., 2: 204-215.

Ge, X., G. Zhu and Y. Zhu, 2003. An improved modeling for network traffic based on alpha-stable self-similar processes. Chinese J. Electron., 4: 494-498.

Ge, X., G. Zhu and Y. Zhu, 2004. On the testing for alpha-stable distributions of network traffic. Comp. Commun. (Elsevier), 5: 447-457.

Ge, X., G. Zhu and Y. Zhu, 2006. Throughput model of IEEE 802.11 networks with capture effect. IEEE WICOM 2006, Sept. 22-24, Wuhan, China.

Jardosh, A., K. Ramachandran, K. Almeroth and E. Royer, 2005. Understanding link-layer behavior in highly congested IEEE 802.11b wireless networks. ACM SIGCOMM 2005, Philadelphia, PA, USA.

Kin, K.L., W.A. Massey and W. Whitt, 1994. Traffic models for wireless communication networks. IEEE. J. Selected Area Commun., 8: 1353-1364.

Kotz, D. and K. Essien, 2005. Analysis of a campus-wide wireless network. J. Wireless Networks, 11: 115-133.

Mahajan, R., M. Rodrig, D. Wetherall and J. Zahorjan, 2006. Ananlyzing the MAC-level behavior of wireless networks in the wild. SIGCOMM 2006, Pisa, Italy.

Papagiannaki, K., M. Yarvis and W. Conner, 2006. Experimental characterization of home wireless networks and design implications, IEEE INFOCOM 2006, Dec 12-15, Barcelona, Spain.

Reis, C., R. Mahajan, M. Rodrig, D. Wetherall and J. Zahorjan, 2006. Measurement-based models of delivery and interference in static wireless networks. SIGCOMM 2006, Pisa, Italy.

Rodrig, M., C. Reis, R. Mahajan, D. Wetherall and J. Zahorjan, 2006. Measurement-based characterization of 802.11 in a hotspot setting. ACM SIGCOMM 2006, Aug 22-26, Philadelphia, PA, USA.

Ware, C., J. Judge, J. Chicharo and E. Dutkiewicz, 2000. Unfairness and capture behavior in 802.11 ad hoc networks. IEEE International Conference on ICC 2000, 1: 18-22.

Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) WG, 1997. ISO/IEC IEEE 802.11 Standard.

Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, 1999. ISO/IEC IEEE 802.11 Standard Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: High-Speed Physical Layer in the 5 GHz Band, 2000. IEEE 802.11 a standard.

Xu, S., S. Papavassiliou and S. Narayanan, 2004. Layer-2 multi-hop IEEE 802.11 architecture design and performance analysis. IEE Proc. Commun. October 2004, Vol. 151, No. 5.

Yin, S. and X. Lin, 2005. Traffic self-similarity in wireless mesh network. Commun. Sci. (In Chinese), 21: 53-55.

Ziouva, E. and T. Antonakopoulos, 2002. CSMA/CA performance under high traffic conditions: Throughput and delay analysis. Comp. Commun., 3: 313-321.